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# A SHAKER AND MODIFIED BERLESE FUNNEL FOR EXTRACTING ALFALFA WEEVILS FROM BALED HAY

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An investigation to determine the danger of dissemination of the alfalfa weevil (Hypera postica Gyll.) through shipments of baled hay was undertaken in the fall of 1936. Minute examination of the great mass of material from hay bales offered a serious problem, since by methods previously used 2 weeks or more were required to examine one bale. Thus, it became necessary to develop a less tedious, yet efficient, method in order that large numbers of bales could be examined. Experiments with Berlese funnels of the type developed by Christenson2/ led to the development of a large, shallow funnel capable of holding a cubic foot of chaff. The increased capacity permitted rapid and efficient examination of large quantities of material. Further efficiency was achieved by the construction of a motor-driven shaker capable of reducing the volume of material to be examined by two-thirds. Thus, with these instruments, a bale of hay can be examined in less than a day and with greater accuracy than by visual examination. A summary of the development of these methods has been published.3/

## Motor-driven Shaker

Details of the shaker construction are shown in figure 1. The shaker base is constructed of 2 by 6 inch pine boards and is 102 by 39½ inches. The entire apparatus, consisting of the shaker itself and the eccentric mechanism, is fastened to this frame. The shaker is attached by means of four flexible hickory shafts or rocker arms similar to those used by Campbell and Stone on

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1/ The work on which this paper is based was carried on under the direction of John C. Hamlin, in charge of alfalfa weevil investigations at Salt Lake City.

2/ Christenson, L. D. A Berlese funnel for collecting smaller soil animals. U. S. Department of Agriculture, Bur. Ent. and Pl. Quar., ET-81 (multigraphed), May 1936.

3/ Hamlin, J. C., and Bunn, R. W. Current research on quarantine aspects of the alfalfa weevil problem. U. S. Dept. Agr., Bur. Ent. and Pl. Quar., E-404 (multigraphed), April 1937.

their soil sifter.4/ These are constructed from 1 by 2 inch material cut down to ½ inch except at the ends. Each is fastened securely to the base by two bolts, at the top, loosely by a single bolt to a shaker frame or tray support. This frame is 50 by 38 inches, constructed of 1 by 4 inch oak with the corners securely fastened by angle irons and screws. A lower tray fits snugly into this frame. This tray is 48 by 36 inches, constructed of 1 by 4 inch oak, and has a bottom of 16-mesh screen. A tray of the same size which fits onto the top of the lower tray is made of 1 by 8 inch oak and has a bottom of 2½-mesh hardware cloth. The upper tray is held in place by 1-inch metal straps screwed to the lower tray.

Located on the other portion of the shaker base are the motor and the eccentric mechanism. A 1-horsepower motor is bolted to a platform attached to the shaker base. Two 2 by 8 inch oak boards bolted to the shaker base and extending upward serve as a support for the eccentric mechanism and are strengthened by a connecting board at the top, together with wire braces and by 1 by 4 inch oak braces.

The eccentric mechanism5/ consists of an iron pipe of 1-15/16 inches outside diameter, having a bend in the middle ½ inch off center, allowing a 1-inch "throw" of the shaker. The ends of this pipe extend through 2-inch holes in the supports. The pipe is held securely in place by a metal cap on one end and a 20-inch flywheel on the other. The flywheel in turn is connected to the motor by means of a belt. Frequent lubrication through oil holes in the eccentric support reduces friction and prevents excessive wear of the bearings.

The eccentric and the shaker frame are connected by a strap-iron pipe hanger fitting onto the eccentric, which in turn is bolted to a short, wooden connecting rod. This connecting rod is fastened to the tray support by a bolt and two angle irons. The strap-iron pipe hanger wears out with continued use in spite of frequent lubrication, but is cheap and easily replaced.

In operation, flakes of baled hay are removed from a large canvas bag and placed in the upper tray of the shaker. These flakes are torn apart and churned vigorously by hand, while the trays are being oscillated by the machinery. Leaves and finer material fall through to the lower screen and the coarse material on the upper screen is discarded. On continued shaking, much of the fine material drops through the lower screen to the floor. Finally only the stems remain. Material remaining on the lower screen is then collected and treated in the Berlese funnels for extraction of living weevils.

## Modified Berlese Funnel

Preliminary experimentation in extracting living weevils from hay chaff by means of Berlese funnels revealed that under certain conditions all the weevils could be extracted. Thick masses of hay chaff, being excellent insulat-

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4/ Campbell, R. E., and Stone, M. W. Soil sifters for subterranean insects. U. S. Dept. Agr., Bur. Ent. and Pl. Quar., ET-49 (multigraphed), May 1935.
5/ This eccentric was devised by J. H. Osborne, assistant custodian, Federal Building, Salt Lake City, Utah.

ing material, did not allow sufficient penetration of heat to drive weevils from the chaff, except when exposed to heat for very long periods. Furthermore, they so impeded the movement of weevils that many of them were unable to escape before being overcome and killed by the heat. Thus, it was concluded that for complete extraction weevil-infested chaff should be treated only in thin layers. Consequently the ordinary small Berlese funnel was inadequate to treat the great mass of material to be examined. Hence, a large modified Berlese funnel, 47 inches in diameter, was constructed capable of holding a cubic foot of hay chaff even when spread only 1 to 2 inches thick. It was found that 1000-watt lamps gave sufficient heat in the large funnel to cause 100 percent of the living weevils to leave the chaff within 1½ hours of exposure.

The funnel is 53 inches high over-all and constructed of 26-gage galvanized sheet metal. It consists of a hopper 47 inches in diameter and 10½ inches high, tightly joined to a cone 36½ inches high which slopes from a top diameter of 47 inches to a bottom opening of only 2½ inches (fig. 2). Three 1-inch angle-iron legs bolted to the hopper support the funnel and raise the bottom of the cone 6 inches above the floor. The leg bolts also hold strap-metal angle irons inside the hopper, which serve as a support for the chaff container. Wires strung between the inside supports prevent the chaff container from sagging.

The chaff container is constructed of 3-mesh hardware cloth and is 45 inches in diameter and 4 inches high. It fits loosely into the hopper, resting on the supports and wire braces. The container is sufficiently rigid to permit removal after exposure of each charge of chaff without collapsing.

The hopper lid is constructed of ¾-inch 5-ply wood 50 inches in diameter with a disk of insulating board securely bolted to the under side. The bolts also hold 13 sockets for the lamps serving as the heating element of the funnel. The insulating disk fits snugly into the hopper to prevent loss of heat. The hopper lid is raised by ropes extending from lid handles through overhead pulleys, and is held by a heavy anchor while the chaff container is emptied and replaced.

In operation a cubic foot of chaff is spread evenly over the chaff container. The fine material falling through the meshes is caught on a tray under the cone opening and is redistributed over the coarser chaff. A wide-mouth pint fruit jar is then placed under the cone opening, the lid lowered, and the heat turned on. As the heat accumulates, weevils drop from the chaff container, along with a small amount of chaff, and slide down the steep incline of the cone into the catch jar. This jar is equipped with rubber gaskets cut from inner tubes of automobile tires, which fit snugly about the cone, preventing the escape of weevils. After each charge of chaff has been exposed for 1½ hours, the catch jar is removed, covered, and set aside while another charge of chaff is placed in the funnel. The operations of replacing chaff and catch jar and lowering the hopper lid require about 5 minutes. Weevils collected in the catch jars are quickly counted, since very little other material is present. Most efficient operation is obtained when one man operates the shaker and three funnels. Photographs of this equipment are included in multigraphed Circular E-404.

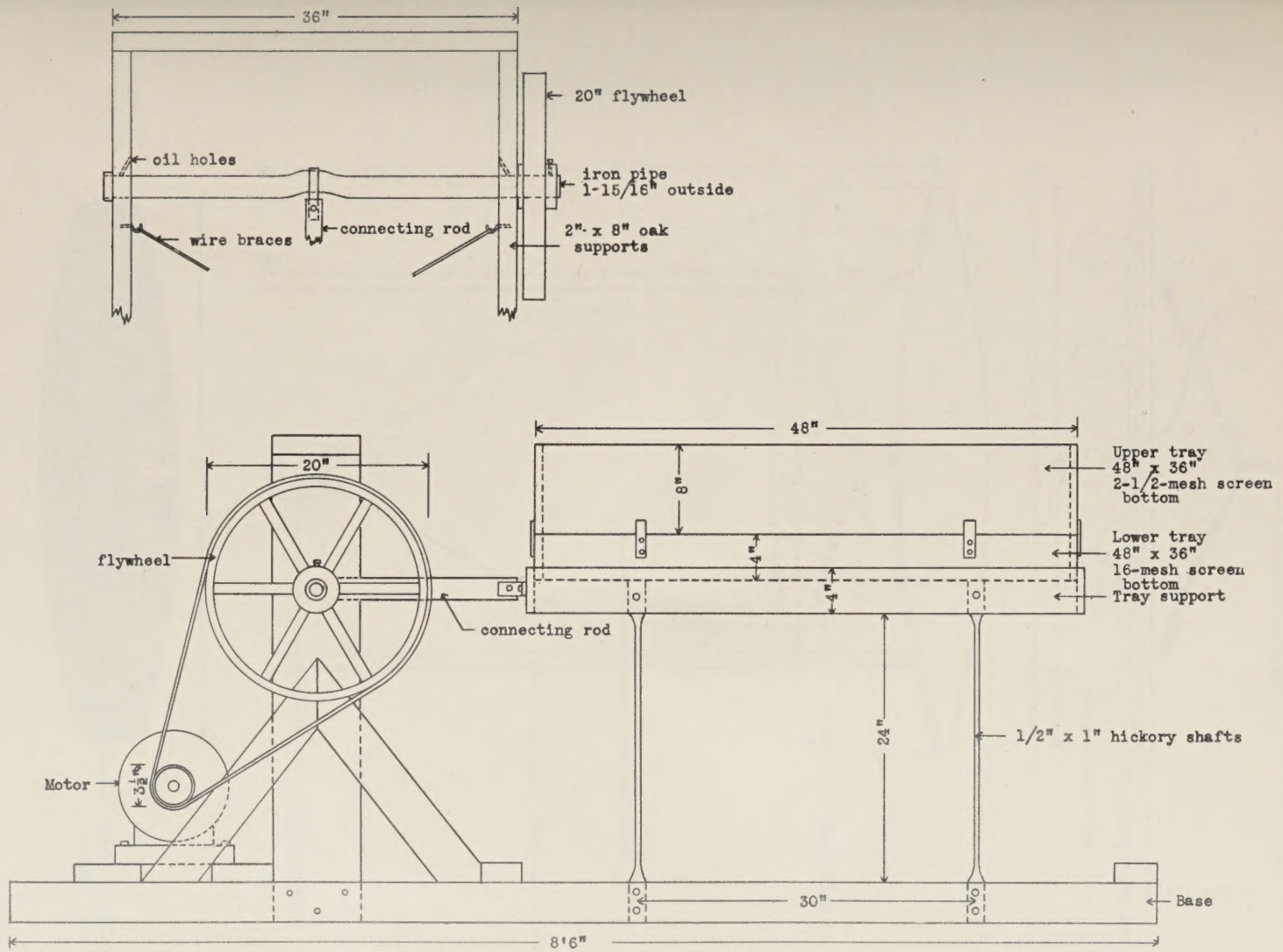


Figure 1.—Motor-driven shaker. Upper figure: End view, showing details of eccentric mechanism. Lower figure: Side view of shaker.

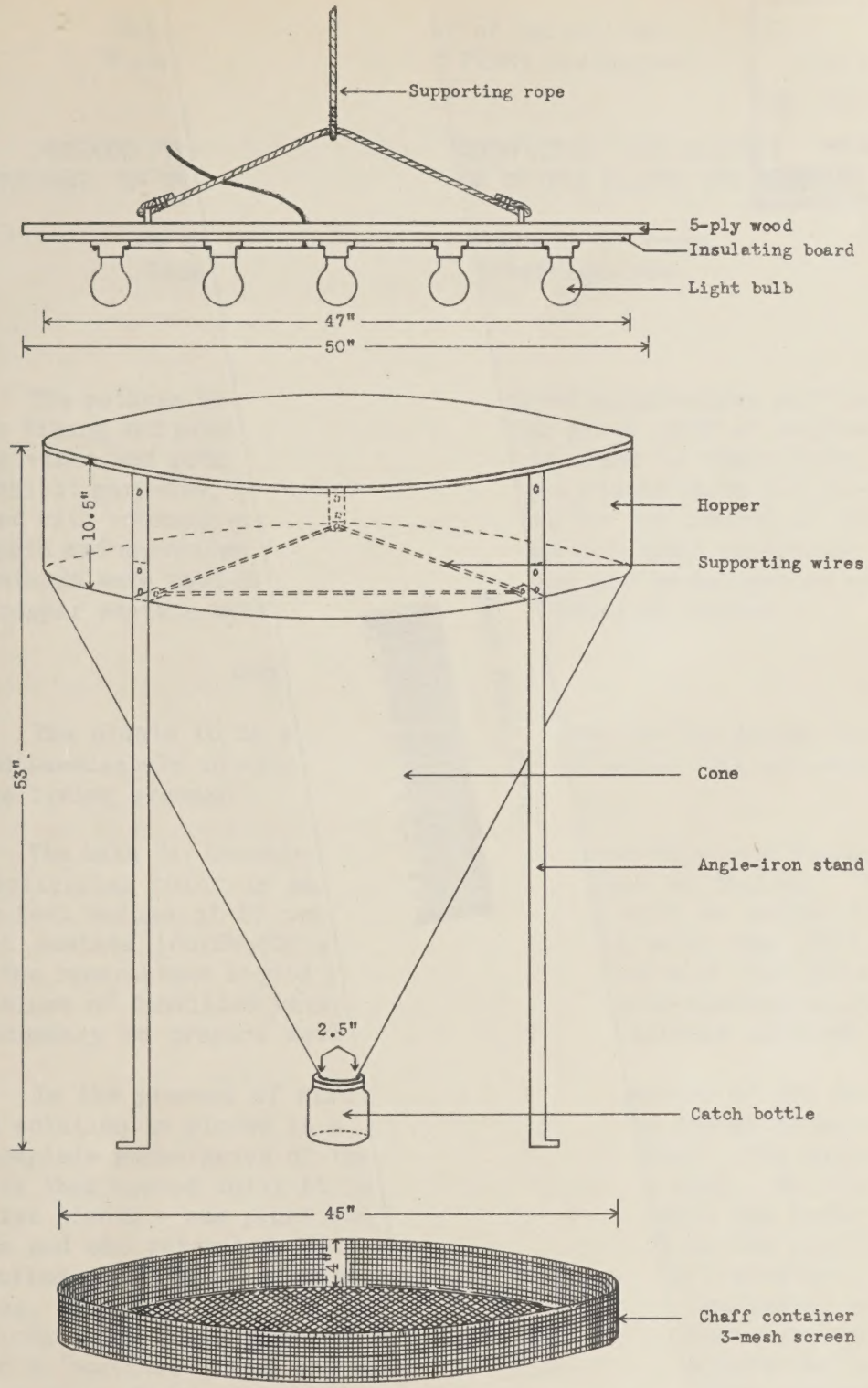


Figure 2.—Modified Berlese funnel.